

SOME DENDROID GRAPTOLITES FROM NEW SOUTH WALES.

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(Plates vii-viii; two Text-figures.)

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Dendroid graptolites have been found in New South Wales in the Ordovician and Silurian but have not yet been recorded from other geological systems. In most cases the exact geological horizon in which the dendroids occur can be determined from true graptolites which accompany them. The Dendroidea have received little attention in this State in comparison with their companion order, the Graptoloidea, which have been quite extensively recorded and described. In spite of this neglect their occurrence here is particularly noteworthy, since many of them are found in horizons where they are unusual in other parts of the world.

For instance, slate from the *Nemagraptus pertenuis* zone of the Ordovician at Tomingley contains the dendroids *Callograptus*, *Dendrograptus* and *Desmograptus* in association with the graptolites *Orthograptus calcaratus* var. *acutus*, *O. whitfieldi*, *Dicellograptus patulosus*, *Climacograptus antiquus*, *Amplexograptus perexcavatus* and *Retiograptus geinitzianus*, which accurately determine the zone. Dendroids have seldom been recorded from this horizon elsewhere, while further, an association of so many dendroids with so many graptolites seems rare.

The only closely, though not entirely, similar associations known to be recorded are from the Normanskill zone of the Ordovician in New York and Arkansas, U.S.A. (Ruedemann, 1947). In Britain, *Callograptus* has been found both lower and higher in the Ordovician, but is not recorded from the *Nemagraptus* zone (Bulman, 1934). Records from other places list only one of the genera of dendroids occurring at Tomingley in association with graptolites of the same zone. For example, the *Nemagraptus gracilis* zone of Sweden is recorded as containing *Desmograptus* ? *tullbergi*, but no other dendroid in association with an assemblage of graptolites somewhat similar to those at Tomingley (Hadding, 1913). Decker (1951) records from Oslo, Norway, *Callograptus compactus* with *Orthograptus calcaratus* var. *acutus*, *Climacograptus antiquus* and *Glyptograptus teretiusculus*. An interesting record is that of T. S. Hall (1904), of shale pebbles in a Jurassic conglomerate at San Remo, Victoria, which were found to contain *Callograptus*, *Ptilograptus* and *Dictyonema* with *Dicellograptus* and *Diplograptus*. However, the provenance of the graptolite-bearing inclusion, which must be Ordovician, is not recorded.

In addition to these associations in the Ordovician in New South Wales, in the Silurian here, the dendroid *Dictyonema* has been found on horizons different from those from which it is recorded in Britain and America. For example, its occurrences in the zones of *Monograptus nilssoni* and *M. scanicus* in the Yass district (Sherrard, 1954) are stratigraphically considerably higher than is usual for *Dictyonema* in the Silurian of Britain (Bulman, 1934) or North America (Ruedemann, 1947). However, dendroids have been obtained in high Silurian horizons of Czecho-Slovakia (Perner and Kodym, 1922) and of North Africa (Termier, 1948).

Dictyonema cf. *filiramus* from Heathcote, Victoria (Harris and Thomas, 1941), where it is associated with *Monograptus* cf. *nilssoni*, may come from about the same horizon as the New South Wales occurrences. *Dendrograptus* has been recorded from the Silurian of Yass (Shearsby, 1912). It is possible this is the specimen which is now in the Australian Museum and is figured here as a proximal end of ? *Dictyonema* sp. (Pl. viii, fig. 10).

Though some of the dendroids described in this paper are comparable in dimensions with species described from other parts of the world, since they occur here in different horizons, references to existing species have seemed unwise and new ones have been erected.

Possibly due to the chances of collecting, all the Ordovician dendroids found up to the present have been in the central west of the State. It may also be chance that no dendroid has been found in the zone of *Orthograptus quadrimucronatus*, though this zone has been quite extensively searched in the Goulburn, Yass, Queanbeyan and Snowy Mountains areas.

The dendroids from Tomingley are preserved as white impressions on blue-black slate. Unsuccessful efforts have been made to detach them by dissolving the matrix in hydrofluoric acid. Free carbon floated off but no dendroid was dislodged. Similarly an attempt to dissolve in acetic acid the calcareous slate of Licking Hole Creek from around ? *Thamnograptus* failed. Consequently the structure of the dendroids could not be studied. The term "theca" in this paper is used in the sense understood generally in descriptions of graptolites. The classification adopted in the Systematic Descriptions is that of Bulman (1938).

SYSTEMATIC DESCRIPTIONS.

Class GRAPTOLITHINA.

Order DENDROIDEA.

Family DENDROGRAPTIDAE.

In this family the stipes spring from some central process. They are arranged in either tree-like or reed-like fashion and branch in various ways. They may or may not be connected by dissepiments.

Genus DICTYONEMA.

This net-like genus, the longest and best known of all dendroid graptolites, has been found in both Ordovician and Silurian rocks of this State, though never entirely complete, but fragments recognizably conical in shape have been obtained.

ORDOVICIAN.

DICTYONEMA APERTUM, n. sp. (Pl. vii, fig. 1).

Holotype: Sydney University Reg. No. 7125.

Fragment 5 cm. by 2 cm., incomplete both distally and proximally, has undulating stipes, 8-9 in 10 mm., 0.25 mm. wide proximally and 0.1 mm. distally. They are connected by dissepiments of about 0.3 mm. width making a coarse irregular mesh up to 4.5 mm. long and 1.25 mm. broad, but which may be as small as 0.75 mm. square. Dissepiments sometimes 4-6 in 10 mm. Thecae very indistinct, may be denticulate or occasionally tubular, perhaps 16 in 10 mm. This species has dimensions similar to those of *D. irregulare* from the British Arenigian (Bulman, 1934) or *D. quebecense* from the Tetragraptus Beds of Canada (Ruedemann, 1947). Its precise horizon in New South Wales has not been determined, though it is almost certainly Ordovician.

Associate: None.

Locality: Kerr's Ck., Portion 57, Parish of Larras Lake, Orange district.

DICTYONEMA SALEBROSUM, n. sp. (Pl. vii, fig. 3).

Holotype: Sydney University Reg. No. 7126.

Rhabdosome preserved in slight relief in limestone, 4 cm. by 3 cm. revealed. Stipes 19 in 10 mm., each 0.3 mm. wide with 0.3 mm. between. Dissepiments indistinct, perhaps 7-8 in 10 mm., each about 0.25 mm. wide. Mesh regular. Denticulate thecae distinct, nearly 20 in 10 mm. The dimensions of this *Dictyonema* are comparable with *D. densum* Ruedemann from the Ottosee Shale of Tennessee.

Associates: *Glyptograptus teretiusculus*, *Leptograptus* cf. *validus*.

Locality: The Bluff, north bank, Belubula R., north-west of Cliefden Caves, Mandurama district.

Horizon: Zone of *Nemagraptus pertenuis* (Sherrard, 1954).

SILURIAN.

DICTYONEMA FAVOSUM, n. sp. (Pl. vii, fig. 2).

Holotype: Sydney University Reg. No. 7128.

Rhabdosome, incomplete cone, more than 7 cm. wide and 4 cm. long. Extreme proximal and distal ends covered. Stipes 13 to 18 in 10 mm., each 0.25 mm. wide and 0.5 mm. apart, bifurcating at about 1 cm. intervals. Stipes undulate slightly. Dissepiments irregular, sometimes at 1, sometimes at 2 mm. intervals apart, each 0.2 mm. wide, making a coarse, fairly regular mesh. Denticulate thecae, 10 in 10 mm., sometimes indistinct. This species has also been collected at Hatton's Corner, Yass, in association with *Monograptus bohemicus* (Brown and Sherrard, 1952, Pl. viii, fig. e, specimen No. F 44611, Australian Museum).

Associate: ? *Monograptus bohemicus*.

Locality: (g6), Quarry Ck., west of Orange (Packham and Stevens, 1955).

Horizon: Lower Ludlow.

DICTYONEMA VINCULOSUM, n. sp. (Text-fig. 2).

Holotype: Australian Museum No. F 46388.

Rhabdosome conical, incomplete, length 1.5 cm., breadth about 1 cm., proximal end not preserved. Stipes 16 per 1 cm. proximally, 22 per 1 cm. distally, each 0.12 mm. wide. Stipes bifurcate six times in 1 cm. Dissepiments about 12 per cm., each 0.1 mm.



Text-figure 1.—*Reticulograptus undulosum*, n. sp., Paling Yards Public School Site, west of Orange. Lower Ludlow.

Text-figure 2.—*Dictyonema vinculosum*, n. sp., Portion 34, Par. Derrengullen. Zone of *Monograptus scanicus*.

wide. Mesh fine and fairly regular. No thecae can be distinguished. A proximal end in the form of a short thickened stem is shown on a ? *Dictyonema*, No. F 46390 (Australian Museum) from the Bowning district, which probably belongs to this species (Pl. viii, fig. 10). The holotype, preserved as a delicate iron oxide net on brown sandstone, has proved impossible to photograph.

Associate: *Monograptus salweyi*.

Locality: Portion 34, Par. Derrengullen (Siverdale), north-west of Yass.

Horizon: Zone of *M. scanicus*.

A *Dictyonema* which is too poorly preserved for specific description has been found in the Llandovery at Quarry Creek, west of Orange (Packham and Stevens, 1955). This *Dictyonema* is thus from a different horizon from any of those described. A key to the characters of those *Dictyonemas* described is given in Table 1.

Genus RETICULOGRAPTUS.

RETICULOGRAPTUS UNDULOSUM, n. sp. (Pl. vii, fig. 4, Text-fig. 1).

Holotype: Sydney University Reg. No. 7129.

Graceful, curving rhabdosome, 4 cm. wide by 2.5 cm. long, but not all uncovered. Most proximal part, a narrow stem, probably incomplete, is curved into a semi-circle. After 4 mm., bifurcates twice to four more or less strongly curved concentric stipes, which are packed into a width of 2 mm. Proximally each stipe is about 0.2 mm. wide with spaces of 0.4 mm. between each. Each stipe bifurcates about twice each centi-

TABLE 1.
Character of Forms Ascribed to Genus Dictyonema.

Species	<i>apertum.</i>	<i>salebrosum.</i>	<i>favosum.</i>	<i>vinculosum.</i>
Rhabdosome	Fragmentary.	Fragmentary.	Incomplete cone.	Incomplete cone.
Length (cm.)	5+	4+	7	1.5
Breadth (cm.)	2	3+	4	1.8
Mesh	Coarse, irregular.	Regular.	Fairly regular.	Fine regular.
Proximal end	—	—	—	? Thickened stem.
Bifurcation in 10 mm.	$\frac{3}{4}$	$1\frac{1}{2}$	1	6
Stipes in 10 mm.	8-9	19	13-18	16-22
Spaces between stipes (mm.)	0.75 (prox.) 1.25 (dist.)	0.3	0.5	0.2
Dissepiments in 10 mm.	4-6	7-8	10-5	12
Width of stipes (mm.)	0.25-0.1	0.3	0.25	0.12
Width of dissepiments (mm.)	0.3	0.25	0.2	0.1
Shape of thecae	Denticulate.	Denticulate.	Denticulate.	—
Number in 10 mm.	? 14-16	20	? 10	—
Age	? Ordovician.	Ordovician Zone of <i>Nemagraptus</i> <i>pertenuis</i> .	Silurian Lower Ludlow.	Silurian Zone of <i>Monograptus</i> <i>scanicus</i> .

metre, until in the most distal part there are 17 stipes, each 0.2 mm. wide and 0.5 mm. apart. Dissepiments 0.1 mm. wide and about 0.1 mm. apart. These are at right angles to the stipes proximally but distally are strongly inclined and anastomose among themselves, forming a net such as is seen in *Retiograptus*. Sharply denticulate thecae, some apparently spined, are arranged five in 3 mm. These can be seen in the proximal portions of some stipes.

Associates: *Monograptus bohemicus tenuis*, *M. nilssoni*, *M. leintwardensis* var. *primus* (Packham and Stevens, 1955).

Locality: Paling Yards Public School Site, west of Orange.

Horizon: Lower Ludlow.

Genus CALLOGRAPTUS.

James Hall, in erecting the genus *Callograptus* (1865) wrote: "the aspect of these fronds is intermediate between *Dictyonema* and *Dendrograptus*". He indicated thus the variable character of species included in the genus. These fall into two groups, one with stipes which branch rather widely, recalling *Dendrograptus*, and a second with closely set parallel stipes suggesting a relationship to *Dictyonema*. In either group the

stipes are sometimes connected by dissepiments. Miller (1889) chose *Callograptus elegans* as genolectotype. This is a branching or "shrub-like" genus, but can be separated from *Dendrograptus* by the presence of dissepiments. The other group is centred round *C. salteri*, which has numerous parallel stipes, occasionally connected by dissepiments, but is without the extreme regularity of *Dictyonema*. Representatives of both these groups can be recognized in the Ordovician of New South Wales, though so far none has been seen from rocks of any other age. The *C. elegans* group is represented by a small, shrubby rhabdosome from Cadia, *C. disjectus*, n. sp., while *C. arundinosus*, n. sp., is a representative of the other group.

CALLOGRAPTUS DISJECTUS, n. sp. (Pl. viii, fig. 4).

Holotype: No. F 39532, Australian Museum.

Small, complete, shrubby rhabdosome, 1.8 cm. wide by 1.5 cm. high, branching from a central stiff stem (0.5 mm. wide), which bifurcates at angles of 30 degrees once in about every 1.25 mm., making ultimately 36 stipes in a fan of 270 degrees, each stipe being about 0.25 mm. wide with spaces of 0.5 mm. between them. Proximally the stipes are stiff. Distally they bend gracefully back and are connected by a few thin dissepiments. Thecae (15 in 10 mm.) are indistinct, their apertures appearing to be introverted, though occasionally prolonged to tubes.

Associates: *Nemagraptus pertenuis*, *Climacograptus antiquus*.

Locality: Cadia.

Horizon: Zone of *Nemagraptus pertenuis*.

CALLOGRAPTUS ARUNDINOSUS, n. sp. (Pl. viii, figs. 1, 2).

Holotype: Australian Museum No. F 46382.

The *Callograptus salteri* group is represented in New South Wales by handsome bamboo-like dendroids up to 4.0 cm. high by 2.0 cm. wide, *C. arundinosus*, n. sp. The stipes are arranged in two clumps, which separate near the base, the nature of which cannot be determined. The nearly parallel stipes are 0.6 mm. wide proximally decreasing to 0.3 mm. wide, distally, with spaces of 0.6–0.8 mm. between them. The stipes undulate very slightly and bifurcate about every 3 mm. until there are about 30 stipes in a width of 2 cm. distally. They terminate in trident-like points. Dissepiments are few and very thin. Inconspicuous thecae, sometimes tubular, are 15 in 10 mm.

Associates: *Orthograptus whitfieldi*, *O. calcaratus* var. *acutus*, *Dicellograptus patulosus*.

Locality: Tomingley village, mine spoil-heap.

Horizon: Zone of *Nemagraptus pertenuis*.

A key to the character of the species placed in this genus is shown in Table 2.

Genus *DENDROGRAPTUS*.

This genus contains dendroids with a strong central stem arising, when complete, from an expanded root-like extension and spreading distally into shrub-like branches which are never connected by dissepiments. None of the specimens from New South Wales is entirely complete, but the preservation is sufficiently good to establish two new species and possibly a third.

DENDROGRAPTUS RECTANGULOSUS, n. sp. (Pl. viii, figs. 3, 6).

Holotype: Australian Museum No. F 46383.

Rhabdosome incomplete, 2 cm. by 2 cm. This species has a shrubby character and shows no anastomosis. It springs from a horizontal stem which is 4.5 mm. long by 1.0 mm. wide. Its stipes are up to 2 cm. long and 0.7 mm. wide, decreasing distally to 0.3 mm. and bifurcating in zigzag fashion almost at right angles, 4 to 6 times in 1.3 cm. Distally there are 11 branches in 2 cm. Thecae, 14 in 10 mm., are generally denticulate, with occasionally short tubes or spines extending from the denticle for 0.5 mm. These tubes or spines are more strongly developed in some specimens, giving a feathery appearance to the rhabdosome (Pl. viii, fig. 3). In these cases the bifurcation of the branches takes place at less than a right angle. These dendroids suggest

Dendrograptus serpens Hopk. figured by Hopkinson and Lapworth (1875), which came from a slightly lower horizon than *D. rectangulosus*.

Associates, locality, horizon: as for *Callograptus arundinosus*.

DENDROGRAPTUS NUDUS, n. sp. (Pl. viii, fig. 5).

Holotype: Australian Museum No. F 46384.

This species is of the *Dendrograptus rigidus* type, having a straight, narrow rhabdosome, 3.0 cm. long by 1.5 cm. wide. The main stem is 0.5 mm. wide. The few branches leave the main stem at 35–50 degrees at intervals of 2 to 3 mm. and decrease in width to 0.3 mm. Thecae denticulate and indistinct, perhaps 15 in 10 mm. This species shows some resemblance to *Thallograptus succulentus* (Ruedemann, 1947) but the stipes of *T. succulentus* are composed of bundles of thecae, which are not observed in *D. nudus*.

Associates, locality, horizon: as for *Callograptus arundinosus*.

TABLE 2.
Character of Forms Ascribed to Genera Callograptus and Desmograptus.

Species	<i>disjunctus</i> .	<i>arundinosus</i> .	<i>quinquelateralis</i> .	<i>spongiosus</i> .
Rhabdosome	Shrubby.	Bamboo-like.	Pentagonal.	Oval.
Length (cm.)	1.5	4	6	0.75
Breadth (cm.)	1.8	2	6	0.9
Proximal end	Stiff stem.	—	Stem.	Stem 0.7 mm. wide.
Bifurcations in 10 mm.	8	3	7	10–15
Mesh	—	—	Pointed, elliptical.	Oval.
Stipes in 10 mm.	20	15	8–12	16
Spaces between stipes (mm.)	0.5	0.8–0.6	1.2–0.3	0.8–0.6
Width of stipes (mm.)	0.25	0.6–0.3	0.7–0.25	0.4
Shape of thecae	? Tubular.	Tubular.	Denticulate or tubular.	? Denticulate.
Number in 10 mm.	15	15	13	—
Age	All from Ordovician, Zone of <i>Nemagraptus pertenuis</i> .			

? *DENDROGRAPTUS*, sp. (Pl. viii, fig. 8).

The strongly curved stipes of a small dendroid, 1.5 cm. by 1.5 cm., suggest the genus *Aspidograptus*, but other attributes exclude it from that genus. It has a central knot of attachment, 2 mm. long by 1 mm. wide. Stipes curve from either end of this, each 0.5 mm. wide. One stipe curves in a semi-circular sweep above the central knot and the other below it. Each stipe bifurcates after each millimetre, sending out a branch about 0.1 mm. wide at an angle of 40 degrees. Obscure traces of denticulate and tubular thecae occur at 0.5 mm. intervals. Circular apertures of ? thecae can also be seen on stipes and branches (eight in 6 mm.). The diagnosis of *Aspidograptus* requires first, branching from the convex side only of the main stipe, and second, stipes and branches to be of the same width. Consequently this specimen must be excluded from *Aspidograptus* and probably included in *Dendrograptus*.

Associates, locality, horizon: as for *Callograptus arundinosus*.

A key to the *Dendrograpti* described is given in Table 3.

Genus *DESMOGRAPTUS*.

This genus has a net-like form like *Dictyonema*, but it is distinguished from that genus by the frequent anastomosis of its undulating stipes.

DESMOGRAPTUS QUINQUELATERALIS, n. sp. (Pl. vii, figs. 5, 6).

Holotype: Australian Museum No. F 46389.

Rhabdosomes almost pentagonal in shape with a horizontal base. Length up to 6 cm. Length:breadth ratio from 1:1 to 1.5:1. Proximal end, where preserved, consists of a vertical or curving stem (1.5 mm. wide, 5 mm. long) from which spring horizontal stipes which turn later through 135 degrees to a vertical direction, frequently branching (six times in 8 mm.). Bifurcation generally more frequent distally. Stipes undulate continuously and anastomose or are connected by dissepiments, making an elliptical mesh with pointed ends, 4-6 times as long as wide. Stipes 0.7 mm. wide proximally

TABLE 3.
Character of Forms Ascribed to Genera *Dendrograptus* and *Ptilograptus*.

Species	<i>rectangulosus</i> .	<i>nudus</i> .	? Sp.	<i>scalaris</i> .	<i>discurrens</i> .
Rhabdosome	Shrubby.	Stiff, bare.	Cyclic.	Stiff, bare.	Zigzagged.
Length (cm.)	2	3	1.5	1	1.2
Breadth (cm.)	2	1.5	1.5	2.5	0.8
Proximal end	Horizontal stem.	Stem.	Knot.	—	—
Bifurcation in 10 mm. ..	3-5	3½	10	12	10
Width of stipes (mm.) ..	0.7-0.3	0.3	0.5-0.1	0.25	0.2
Shape of thecae	Denticulate and tubular.	Denticulate.	Denticulate and tubular.	Denticulate, spined.	Denticulate.
Age	Ordovician, Zone of <i>Nemagraptus pertenuis</i> .			Ordovician, Zone of <i>Orthograptus calcaratus</i> .	Silurian, Upper Llandovery.

and 0.25-0.5 mm. distally; 8-12 stipes per cm. of width (distally), spaces between are the same width as the stipes proximally but open out to 2-3 times as wide to form the mesh. At their distal ends the stipes break into fork-like ends, as in *Desmograptus ? tullbergi* Hadding, which occurs on the same horizon in Sweden. Thecae 13 in 10 mm., tubular or denticulate, while circular breaks in the white chitin (eight in 6 mm.) may be apertures. The dimensions of *D. quinquelateralis* are not unlike those of *Desmograptus vermicularis* Ruedemann from the *Nemagraptus* horizon of Arkansas.

Associates, locality, horizon: as for *Callograptus arundinosus*.

DESMOGRAPTUS SPONGIOSUS, n. sp. (Pl. viii, fig. 9).

Holotype: Australian Museum No. F 46386.

Small, complete and shrubby. Width 9 mm., height 7.5 mm. Stipes 0.3-0.5 mm. wide, which branch five times in 3-4 mm. and undulate and anastomose, making a mesh from once to twice as long as it is wide. The stipes leave a short central main stem 0.7 mm. wide and branches of about the same width as the stipes spring from the stipes. Distal stipes are 15 in 9 mm. with 0.7 mm. space between each stipe. Obscure thecae are denticulate and also seen as circular apertures on main stem. There are a few dissepiments, 0.01 mm. wide.

Associates, locality, horizon: as for *Callograptus arundinosus*.

A key to these *Desmograpti* is given in Table 2.

Family PTILOGRAPTIDAE.

Genus PTILOGRAPTUS.

This genus contains species with a central stem from which branches spring alternately on either side. One Ordovician species and one Silurian species have been recognized.

ORDOVICIAN.

PTILOGRAPTUS SCALARIS, n. sp. (Pl. viii, fig. 11).

Holotype: Australian Museum No. F 46385.

Rhabdosome 1 cm. long and 2.5 cm. wide. Central stem 0.5 mm. wide, increasing to 1 mm. at each point where branches are given off. Eight primary branches (0.25 mm. wide and convex upward) leave the main stem at irregular intervals on alternate sides at an angle of 30 degrees on one side and 80 degrees on the other, this inequality being perhaps due to preservation not being in true profile. The longest branch is 1.3 cm. The branches bifurcate several times at progressively lower angles (40 degrees, 30 degrees and 20 degrees) and at closer intervals (first after 4 or 5 mm., then after 1 mm.). The main stem seems to be made up of bunches of thecae and the main branches to arise from successive thecae. A thickening of the stem can be noticed prior to each branching. There are 13 thecae in 10 mm. on the branches. Thecae denticulate, with some spines. This species is of dimensions somewhat similar to *Ptilograptus acutus* Hopk. from the Lower Llandeilo of St. David's, Wales (Hopkinson and Lapworth, 1875), but comes from a higher horizon.

Associates: *Climacograptus bicornis*, *Orthograptus calcaratus*, *Dicellograptus elegans*.

Locality: Woodstock, quarry, one mile north of railway station.

Horizon: Zone of *Orthograptus calcaratus* and *Plegmatograptus nebula*.

Fragments possibly belonging to this genus have been collected at Tomingley.

SILURIAN.

PTILOGRAPTUS DISCURRENS, n. sp. (Pl. viii, fig. 12).

Holotype: Sydney University Reg. No. 7127.

Rhabdosome 1.2 cm. long and 0.8 cm. wide. Distinctly zigzagged main stem, with branches 10 in 10 mm., which leave the main stem at about 65 degrees. Proximal branches 4 mm. long and 0.2 mm. wide. Distal branches 2.5 mm. long. Branches show longitudinal cords, as are described for *P. glomeratus* by Pocta (1894). These cords are apparently internal sections of thecae. No secondary branching. Thecae distinct, denticulate, about 22 in 10 mm.

Associates: *Monograptus* cf. *pragensis pragensis*, *Dictyonema* sp.

Locality: (g2) Quarry Ck., west of Orange.

Horizon: Upper Llandovery (Packham and Stevens, 1955).

A key to these *Ptilograpti* is given in Table 3.

Family ACANTHOGRAPTIDAE.

In this family the branches are composed of bunches of very long thecae.

Genus ? ACANTHOGRAPTUS, sp. (Pl. viii, fig. 7).

A fragment, 1 cm. by 1 cm., which may be *Acanthograptus* sp., consists of a proximal stem, 1.5 mm. wide, which splits into three flexuous branches. These give off branchlets at 1.5 mm. intervals. Each branchlet widens distally from 0.3 to 0.8 mm. before opening, 10 times in 10 mm., to show bundles of tubular thecae up to 1 mm. long. Short thecal spines are given off between the branchlets. There are circular orifices in the centre of the branches at intervals of 1 mm.

Associates: Locality, horizon: as for *Callograptus arundinosus*.

UNCERTAIN RELATIONSHIP.

? THAMNOGRAPTUS.

Thin, black, linear fragments, giving off at right angles or smaller angles, other linear fragments may represent *Thamnograptus*. The main framework of about 3 mm. length is less than 0.1 mm. wide, with projecting branches about 1 mm. apart. It is possible that these fragments represent the broken off clathria of *Retiograptus geinitzianus*, which is associated with them.

Locality: Licking Hole Creek, Mandurama.

Horizon: *Nemagraptus pertenuis* zone, Ordovician.

Isograptus (Didymograptus) caduceus was also recorded in the assemblage at Licking Hole Creek, the type area for the zone of *Nemagraptus pertenuis* (Sherrard, 1954, Pl. x, fig. 5). While the thecae in this graptolite are typical of the Dichograptidae, being simple tubes with no traces of sigmoidal ventral curvature, its proximal end is like that of a *Dicellograptus*. The graptolite perhaps represents a transitional form not previously recorded.

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EXPLANATION OF PLATES VII-VIII.

Plate vii.

- 1, *Dictyonema apertum*, n. sp. Kerr's Ck., Port. 57, Par. Larras Lake. × 2. Syd. Univ. No. 7125.
- 2, *Dictyonema favosum*, n. sp. Quarry Ck., west of Orange. × 2. Syd. Univ. No. 7128.
- 3, *Dictyonema salebrosum*, n. sp. North-west of Cliefden Caves, Mandurama district. × 3. Syd. Univ. No. 7126.
- 4, *Reticulograptus undulosum*, n. sp. Paling Yards Public School Site. × 4. Syd. Univ. No. 7129.
- 5, *Desmograptus quinquelateralis*, n. sp. Tomingley. × 2. Aust. Mus. No. F 46389.
- 6, *Desmograptus quinquelateralis*, n. sp. Tomingley. × 2.
 (Specimens in Figs. 1, 2 and 4 collected by Mr. G. H. Packham, in Fig. 3 by Mr. N. C. Stevens. Figs. 3 and 4 photographed by Mr. J. S. Mann, Melbourne University.)

Plate viii.

- 1, *Callograptus arundinosus*, n. sp. Tomingley. × 2. Aust. Mus. No. F 46382.
- 2, *Callograptus arundinosus*, n. sp. Tomingley. × 2.
- 3, *Dendrograptus rectangulosus*, n. sp. Tomingley. × 2.
- 4, *Callograptus disiectus*, n. sp. Cadia. × 2. Aust. Mus. No. F 39532.
- 5, *Dendrograptus nudus*, n. sp. Tomingley. × 2. Aust. Mus. No. F 46384.
- 6, *Dendrograptus rectangulosus*, n. sp. Tomingley. × 4. Aust. Mus. No. F 46383.
- 7, ? *Acanthograptus*, sp. Tomingley. × 2.
- 8, ? *Dendrograptus*, sp. Tomingley. × 2. Aust. Mus. No. F 46387.
- 9, *Desmograptus spongiosus*, n. sp. Tomingley. × 4. Aust. Mus. No. F 46386.
- 10, ? *Dictyonema*, sp. Bowning district. × 4. Aust. Mus. No. F 46390.
- 11, *Ptilograptus scalaris*, n. sp. Woodstock Municipal Quarry. × 2. Aust. Mus. No. F 46385.
- 12, *Ptilograptus discurrens*, n. sp. Quarry Ck., west of Orange. × 2. Syd. Univ. No. 7127.
 (Collected by Mr. G. H. Packham.)